Two-dimensional shearless turbulent mixing: kinetic energy selfdiffusion, also in the presence of a stable stratification

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Two-dimensional turbulence is important in many natural and engineering contexts. It presents some special and interesting phenomena that does not occur in three dimensional turbulence. Moreover, it also idealizes geophysical phenomena in the atmosphere, oceans and magnetosphere and provides a starting point for the modeling of these phenomena [1, 2, 3, 4]. In this contest, we would like to present new results concerning the turbulent energy transport in the simplest kind of two dimensional inhomogeneous flow, a turbulent shearless mixing process generated by the interaction of two isotropic turbulent fields with different kinetic energy but the same spectrum shape [5]. The self diffusion of kinetic energy is observed in two cases: with and without a stable density stratification.
In the unstratified case the simulations of mixing with different values of the energy ratio show that, asymptotically in time (in the limit of the observed range), the turbulent diffusion is much larger than the one measured in three dimensions[6, 7], see the full time history in the *movie*. The analysis of velocity third and fourth moments indicates that the flow is highly intermittent. Moreover, the temporal autocorrelation of the vorticity, at some fixed points, does not depend on the ratio of energy used and on the position. We can interpret this results in term of the existence of a long-range interaction.
In the stratified case the evolution of the flow changes significantly [8, 9]. The energy profile in the mixing region is lower than the minimum value imposed by the initial condition, which shows the effect of the buoyancy force work. Finally, the velocity skewness enlightens the generation of an inverse energy flow and intermittent penetration from the low to the high energy field even in the case of mild stratification.

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